Business Week
22 August 1970

RESEARCH

Pooling brains to study the atom

Foreign scientists are participating in a project at Russia's reactor center

The soaring cost of research in high energy physics is activating unprecedented international cooperation.

Next month, five American scientists will travel to Protvino, near Serpukhov, 60 mi. south of Moscow and site of the world's biggest atom smasher, or "particle accelerator." They will work with Russian counterparts on a six-month project studying the pi meson, a tiny subatomic particle that is thought to contribute to the forces that hold the atom's nucleus together. The Americans will be a part of a group of 300 foreign scientists at Protvino, where the Russians have carved a "science city" out of birch forests to house the giant accelerator.

Meanwhile, in Switzerland, the Russians have been working with the Geneva-based CERN (Conseil Européen pour la Recherche Nucléaire) since 1959, and using CERN's atom smasher. And physicists all over the world are eagerly awaiting the completion of another new atom smasher in the U.S., at Batavia, Ill. next year (box). Two Russian scientists spent several weeks at Batavia this summer, planning possible experiments on the accelerator.

Because each of the new machines will cost $250-million or more to build, the giant atom smasher is not the kind of research equipment every country can have. In fact, the high cost has made high-energy physics the most expensive of all fields of scientific research. Thus the cooperation.

Method. The basic concept of atomic particle research is simple. To learn more about the nature of matter, physicists have to understand the particles that make up the atom. More than 100 new particles have been discovered in the past 20 years, ranging from neutrinos to heavy baryons. Their sizes are measured in billionths of inches, their lives in billionths of seconds.

Because they are so tiny and short-lived, the subatomic particles are on the borderline between energy and matter. The only way to produce them is, in effect, for the physicist to hurl together bigger, more manageable particles, such as protons, at close to the speed of light. Energy that comes flying out of the crash is converted briefly into the subatomic particles.

The physicist achieves the speeds necessary for this process by "accelerating" the protons in a circular tunnel, which is lined with magnets to hold the protons away from its walls and speed them up. He detects the subatomic particles by the "tracks" they leave as they travel through a gas-filled or liquid-filled "bubble chamber." To push protons up to the speed of light requires huge equipment, however. The tunnel ring at Protvino is nearly a mile in diameter and the facility cost an estimated $150-million to build. Physicists all over the world covet this accelerator's enormous energy of 76-billion electron volts (or 76 Gev, for Geneva electron volts). But they insist that they need an even more powerful atom smasher, one with an energy of 1,000 Gev or more to really study subatomic particles. And applying a rule of thumb that a particle accelerator costs up to $2-million per Gev, such a machine would cost $2-billion.

Achievements. The precedents for the international cooperation that might achieve this goal have already been set at Protvino and CERN. Although the accelerator at Protvino is only three years old, scientists there have achieved some impressive results.

For one thing, they have discovered matter called anti-helium-3—roughly comparable to ordinary helium, but with opposite electrical charges. And they have cast serious doubts on accepted theories of how negatively charged particles interact with other particles at high energies.

Dr. Roman Sulayev, 44-year-old deputy director of the Center of High Energy Physics at Protvino, is proud of the scientific successes at his accelerator. But he says his colleagues are al-

A massive smasher at a bargain price

The U.S. will acquire the world's most powerful atom smasher—sooner, cheaper, and with a higher energy level than its planners originally expected. Construction at Batavia, Ill., is going "exceedingly well," says Edwin L. Goldwasser, deputy director of the installation, known as the National Accelerator Laboratory.

The atom smasher, being built for the U.S. Atomic Energy Commission, is due to start operations next July, a year ahead of schedule. Its costs are running below the $250-million originally estimated. Its designers anticipate that it will provide energy levels up to 500-billion Geneva electron volts (Gev), way over the 200 Gev they had looked for in early planning.

"Luck, good management, and advancing technology have all helped to brighten an otherwise bleak scene in U.S. physics, hard-hit by budget cutbacks. Several large construction contracts were let for the accelerator just before President Nixon's order last September to cut back federal construction by 75% in fiscal 1970. Other contracts have come in below estimates. Says Goldwasser: "In a recession, contractors are hungry. Moreover, they are ready to move in with no delay."

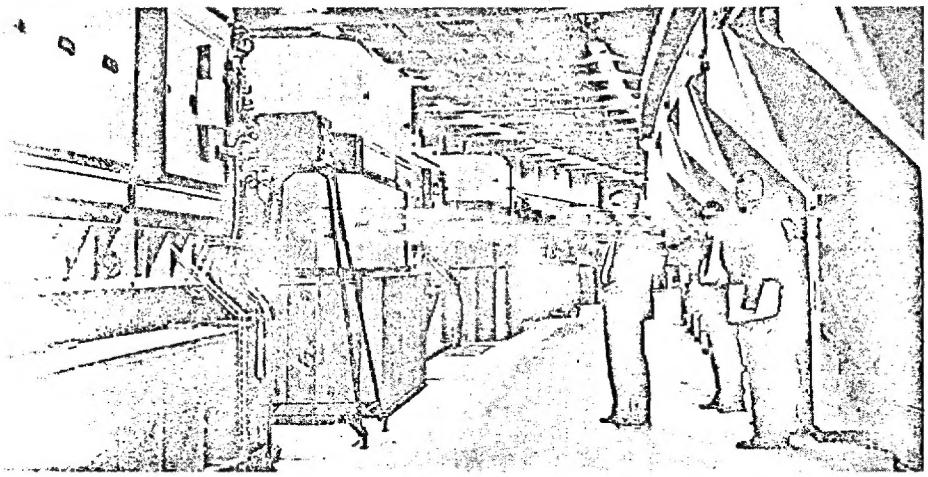
Economies. So far, about $89-million has been spent on the NAL, almost entirely on the accelerator. No money has even been allocated for a 400,000-sq. ft. main research building, which has been given a lower priority by NAL Director Dr. Robert Rathbun Wilson. Labs are temporarily housed in other buildings.

Also to promote economy, Wilson is encouraging competition between his contractors. As one example, he has ordered only two-thirds of the 1,000 magnets needed for the accelerator's main ring, from two separate companies. The company that does the best production job will get the order for the remaining third.

Technical advances account for the boost in the accelerator's rating to 500 Gev. Designers found that circuit-switching devices called thyristors could take higher electrical loads than anticipated, permitting use of much greater electric power.

The NAL will be operated for the AEC by Universities Research Assn., Inc., a consortium of 50 universities. While some experiments will be carried out by the NAL staff, most will be performed by scientists from these and other research facilities.

...nch technicians supervise the installation of the Mirabelle "bubble chamber."



...ant Russian accelerator is becoming a focal point for international research.

Protvino, the site of the accelerator, is one of the Soviet's "science cities."

...ady working to expand its capacity. ...ey have initiated:

- A series of international nuclear ...jects, under which both men and ...plementary research equipment are ...ng shipped to Protvino from Europe ...d the U. S.
- A program to explore whether super...ducting magnets, now experi...tal, can be used to boost its rating.

...operation. The closeness of the Rus...-European cooperation is illus...ted by the projects under way at ...vino. A dozen French scientists ...re are installing a huge, 6,000-liter ...ble chamber called Mirabelle. An...r 40 Frenchmen will join them ...n components of the $9-million ...re, built at the French Atomic .../ Commissariat's Saclay Re...h Center outside Paris, are ship...d to Russia and assembled there. ...belle will remain French property, ... will be used by the French and ...ans under a five-year agreement.

...viet-CERN cooperation is even ... High energy physicists shuttle ... and forth between Russia and ...erland, where CERN has a 28-Gev ... smasher. A formal CERN-Soviet ...ment has been in effect for three ... And a dozen CERN scientists at ...vino have launched the second of ... projects, begun in 1968, to ... particles called heavier neutral ... Last April, the CERN group

including an IBM 1800 computer, all to be returned to CERN.

At the same time, 12 Soviet scientists in Geneva are working with highly sophisticated systems that have been developed at CERN—a fast ejector system to switch particles out of the accelerator and radio frequency particle separators. These systems will be shipped to Protvino in about a year for permanent installation there.

Payoff? Soviet ties with CERN could pay off for the Russians if and when a 300-Gev European accelerator is built. Years of argument over financing and locating this proposed atom smasher caused seven of CERN's 13 partners, including England, to opt out of the project.

Superconducting magnets would sharply boost atom smashers' energy

Last June, however, project director Dr. John B. Adams, a Briton, urged CERN to adopt a radically new proposal. Under its terms the new accelerator would straddle the Swiss-French border at Meyrin and use a 28-Gev atom smasher that is already there as part of its system.

The Adams plan [illegible] quicker than earlier proposals; it could mean only eight years' construction and a cost of $251-million. Therefore, nonparticipating countries back into the fold, and they look for a CERN decision by this Christmas on whether to go ahead.

A vital part of the Adams plan is that, initially, the CERN accelerator would get only half the number of magnets it is capable of using. This would give it a rating of only 150 Gev. But space would be left for installation later of much more powerful magnets—cryogenic superconducting magnets.

These magnets are still in the experimental stage but could permit energy levels of 500 Gev to 800 Gev. If they do not work out, the accelerator would get another set of iron-core magnets, for a maximum rating of 300 Gev.

Russia, too. Superconducting magnets, which are under intensive research at Britain's Rutherford High Energy Laboratory, among other places, are at the heart of Soviet research to boost the rating of the Protvino accelerator, too. According to Sulayev, use of superconducting magnets would boost the atom-smasher's energy level three to eight times—that is, to a maximum of more than 600 Gev. "A lot of work remains to be done in this field—but it is a definite possibility," he says.

Officially, the U. S. has made no commitments to cooperate with Protvino. This winter's visit of the American team, headed by Dr. Darrell J. Drickey of the University of California, Los Angeles, is based on an exchange of letters between Dr. Glenn T. Seaborg, chairman of the U. S. Atomic Energy Commission, and A. Petrosyants, chairman of the Soviet State Committee on the Utilization of Atomic Energy. But scientists in both countries are hoping for stronger links. Says Sulayev: "A wider, more formal

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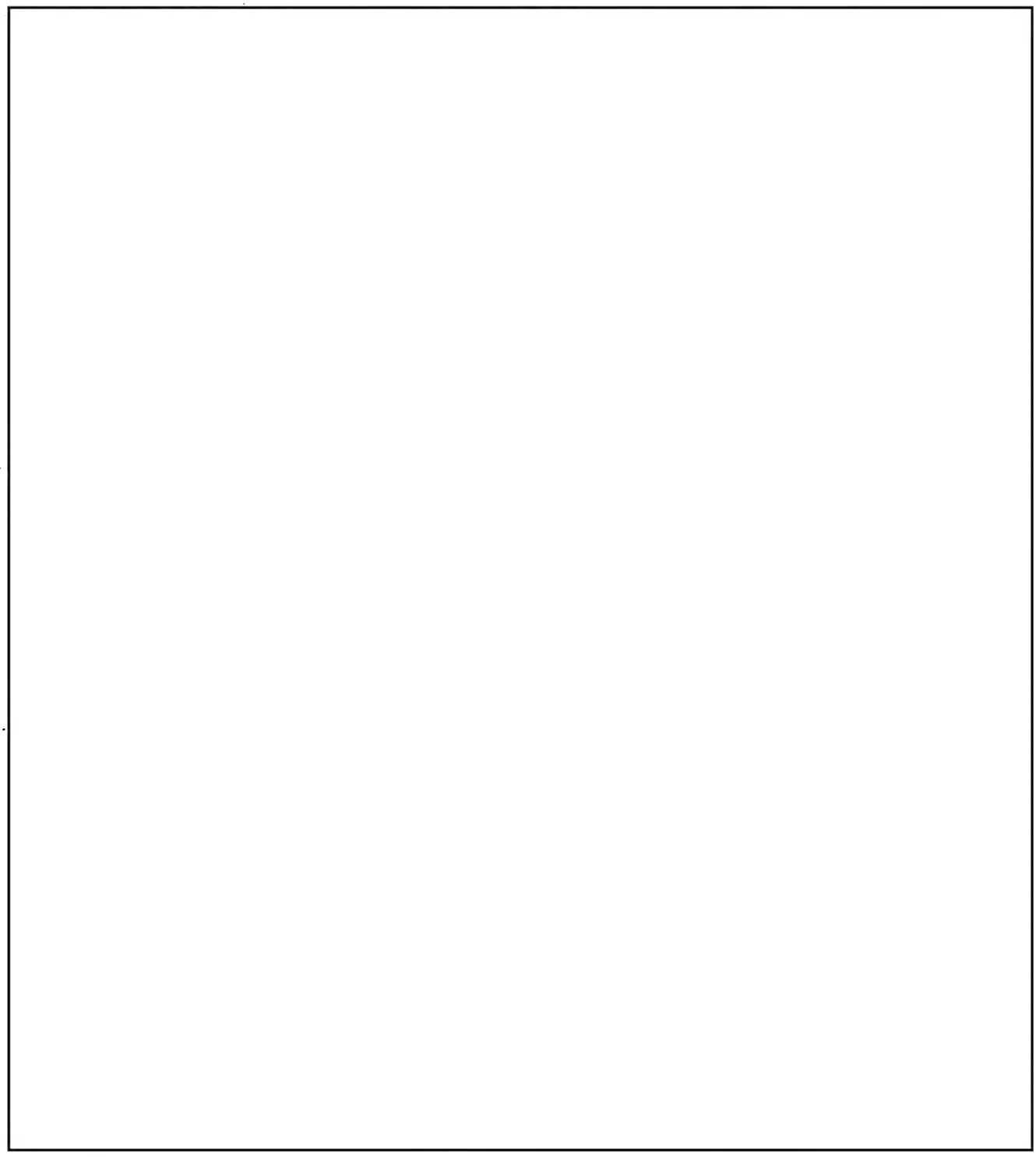

ATTACHMENT

For over a year the US has been considering the export of large computers to Serpukhov and Yerevan to be used in high energy physics and other atomic energy research. In January 1970 US computer experts agreed that installation of a computer of the CDC 6600 class could proceed without threat to national security provided the following conditions prevailed:

(a) Closed shop, with systems programming done by US personnel only, adequate surveillance and assurance of non-use during any off hours.

(b) Batch computing only (no terminals).

(c) Fortran programs only, with adequate documentation required to ensure efficient operation and for verification purposes.

(d) Complete recording input and sampling of output.

(e) Sampling of internal computer executions.

(f) Creation in the United States of a part-time group of high-energy phsicists, computer center managers, and weapons designers to analyze a small sample of the recorded data.

9 SEP 1970

Inside Washington

Speedy Computer Wanted by Soviets

By ROBERT S. ALLEN and JOHN A. GOLDSMITH

WASHINGTON — Some knowledgeable government experts think it was only a lag in Russia's computer technology which enabled U.S. astronauts to beat Soviet cosmonauts to a landing on the moon.

Lt. Gen. A.W. Betts, the Army's research and development chief, recently told a closed-door congressional hearing that he has been so informed. Betts testified that Russia has caught up with the United States "in most fields of technology of military interest."

The general did not elaborate. It is clear, however, that the some aspects of nuclear tech- Russians are actually ahead in hology — notably in data obtained from the most recent series of atmospheric tests, including blasts at high altitude.

Vice Adm. Hyman G. Rickover, the tough-talking "father" of U.S. nuclear submarines, says Russian atomic subs are beginning to outstrip the ones which he has sired. The Kremlin also is speeding the development of high performance aircraft.

Generally, the Russians are aggressively pressing military research and development programs at a pace which is worrying Pentagon planners.

All this explains why some U.S. experts — including Rickover — want to guard the U.S. lead in computer technology as a key to technological advances in other areas. It also helps to explain why Soviet scientists would like to erase the U.S. advantage.

SCIENTIFIC PAY-OFFS — In trying to obtain computer technology from the United States — or, at least, get the use of high-performance U.S. computers — Russian experts have even resorted to a kind of quid pro quo scientific pay-off. Here is the full story of one such attempt which was recently described in censored testimony of the Senate-House Atomic Energy Committee.

In February and March of 1969, five high energy physicists from the United States traveled to Russia to see whether they could use the Russian particle accelerator at Serpukhov. That giant atom-smasher is now the most powerful in the world.

The group of U.S. physicists was headed by Dr. Wolfgang Panofsky of Stanford. Panofsky is the director of the Atomic Energy Commission's mile-long linear particle accelerator at Stanford and was, of course, interested in the Soviet facility.

Panofsky was told by the Soviet authorities, however, that any access by U.S. scientists to the accelerator at Serpukhov would be contingent on the United States' supplying a highly sophisticated U.S.-built central computer facility for use in data analysis. It was even said that the Russians would accept some U.S. controls on use of the computer.

What the Russians wanted was a CDC 6600 computer, or its equivalent, from the United States. Manufactured by Control Data Corp., the CDC is a high-speed computer which is used in U.S. weapons programs. IBM makes a somewhat similar computer facility.

The Soviet demand for a scientific quid-pro-quo was apparently nothing new. French scientists who wanted access to the big, 76 billion electron volt accelerator, had been told that the price would be supply of a bubble-chamber there.

DEMAND VETOED — Panofsky's return to the United States with the Russian computer demand apparently precipitated an argument in the government's scientific community over whether the sophisticated computer should be supplied.

In the late summer of 1969, the Atomic Energy Commission made a survey of the pros and cons of sending a CDC 6600 computer to Serpukhov. Some government scientists who saw the AEC survey thought it underestimated the risks involved in granting an export license for the computer.

That was Rickover's view. Asked to comment on the AEC study in September 1969, Rickover concluded that the Soviet purchase of such a sophisticated computer would not be in the public interest, even if the United States were to retain some controls over the computer's use.

Shortly thereafter, the Senate-House Atomic Energy Committee became interested in the proposed sale. Committee members expressed concern about supplying the computer and, in the words of Chairman Chet Holifield, D-Cal., "We stopped it."

Note — High speed computers from the United States have been made rather freely available to free world nations. Seven of the CDC 6600s have been installed in France, and the facilities have been installed in England, Switzerland, Italy, Sweden, West Germany and Australia.

Certain restrictions are supposed to be in effect with respect to France — and also Israel — to prevent the use of advanced U.S. computer technology to assist in nuclear weapons programs.